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# A case of intensive care unit-acquired weakness after emergency surgery for acute abdomen

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ABSTRACT

*INTRODUCTION:* Surgeons often perform surgery for patients who are critically ill. Intensive care unit (ICU)-acquired weakness (ICUAW) is a condition in which systemic and prolonged muscle weakness occurs and causes worse short-term and long-term outcomes.
*PRESENTATION OF CASE:* A 60-year-old woman with sudden nausea and vomiting presented to our hospital and developed shock. Abdominal CT showed thickness of the descending colon and ascites. She was diagnosed with sepsis due to descending colon cancer. Colectomy of the descending colon was performed due to necrosis, and a stoma was created. After surgery, she received intensive care in the ICU. It was difficult to wean her from the ventilator, and she developed severe flaccid weakness of the limbs. Her Medical Research Council (MRC) sum score was 0. Since other organic disorders causing prolonged paralysis were excluded, she was finally diagnosed as having ICUAW. Active rehabilitation, nutritional support, and glycemic control were continued. Now, 6 months after surgery, her MRC score has improved to 30.
*DISCUSSION:* The treatment for ICUAW has been reported to include recovery from the critical illness, early rehabilitation, and nutritional support, and it requires close cooperation among health care providers.
*CONCLUSION:* All physicians and surgeons who care for critically ill patients should take active steps to diagnose ICUAW in order to avoid deterioration of patients' activities of daily living.


## 1. Introduction

It has been reported that marked loss of muscle strength can occur in patients with life-threatening infections [1], and this may also cause an ongoing disorder of function and loss of QOL after discharge from hospital [2]. Intensive care unit-acquired weakness (ICUAW) is such a neuromuscular disorder caused by severe illness treated in the ICU [3]. ICUAW has been reported to occur in various patients, and early rehabilitation is considered very important to prevent prolonged muscle weakness [4,5]. However general surgeons still seem to be insufficiently aware of this clinical condition. A case of ICUAW after severe sepsis is presented.

## 2. Presentation of case

A 60-year-old woman with sudden nausea and vomiting presented to our hospital. She was on steroid treatment for malignant lymphoma. She had pain in the left side of the abdomen, and a large mass was palpable. There was no muscular guarding or rebound tenderness. Laboratory data showed increased inflammation and marked acidosis (Table 1). Abdominal CT showed thickness of the descending colon, swelling of surrounding lymph nodes, and ascites (Fig. 1a, b). Her blood pressure and level of consciousness decreased gradually. She was diagnosed with sepsis due to descending colon cancer. Colectomy of the descending colon was performed due to necrosis, and a stoma was created (Fig. 1c). After surgery, the patient was admitted to the intensive care unit for general care. In the ICU, she received not only treatment for the primary disease,

*Abbreviations:* ICUAW, ICU-acquired weakness; MRC, Medical Research Council.

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**Table 1**
Laboratory data before surgery.

| | |
|---|---|
| Peripheral blood | |
| RBC | $5.54 \times 10^4/mm^3$ |
| Hg | 12.7 g/dl |
| Hct | 43.1% |
| WBC | $50800/mm^3$ |
| Plt | $8.0 \times 10^4/mm^3$ |
| Biochemistry | |
| T-Bil | 0.4 mg/dl |
| AST | 106 IU/l |
| ALT | 71 U/l |
| LDH | 571 IU/l |
| ALP | 155 U/l |
| CK | 139 IU/l |
| AMY 82 | 82 mg/dl |
| Na | 135 mg/dl |
| K | 5.3 mg/dl |
| Cl | 120 mg/dl |
| BUN | 34 mg/dl |
| Cr | 2.74 mg/dl |
| TP | 5.4 g/dl |
| Alb | 3.8 g/dl |
| Procalcitonin | 0.635 ng/ml |
| Coagulation system | |
| PT(%) | 17% |
| PT-INR | 4.15 |
| APTT | unmeasurable |
| AT-III | 21% |
| FDP | 44.6 μg/ml |
| D-dimer | 18.2 μg/ml |
| Blood sugar | |
| BS | 145 mg/dl |
| Blood gases ($O_2$ 10 l) | |
| pH | 6.889 |
| $PO_2$ | 455 mmHg |
| $PCO_2$ | 26.1 mmHg |
| $HCO_3$ | −4.7 mmol/l |
| BE | −28.2 mmol/l |
| Lactate | 13.2 mmol/l |

but also early rehabilitation to prevent muscle atrophy. Though she recovered from multiple organ failure, she had difficulty in being weaned from the ventilator, and a tracheotomy was performed on postoperative day 12. Her level of consciousness was GCS4 (E4VTM0). There was no anisocoria, abnormal light reflex, disorder of eye movement, or facial muscle paralysis. She then developed severe flaccid weakness of the limbs and diminished deep tendon reflexes. Her Medical Research Council (MRC) sum score was 0. Head CT showed no abnormalities causing muscle weakness (Fig. 2). She was diagnosed as having ICUAW from the clinical course and the pathophysiological findings, including the MRC score. Active rehabilitation, nutritional support, and glycemic control were continued. Now, 6 months after surgery, her MRC score has improved to 50 (Fig. 3).

## 3. Discussion

The mortality rate of sepsis in the ICU has improved due to the development of intensive treatment. Currently, not only short-term outcomes, but also long-terms outcomes are being considered during critical care.

In the nineteenth century, loss of flesh and strength in patients with life-threatening disease was reported [6]. In 2009, Stevens and colleagues reported a framework for diagnosing and classifying ICUAW [7]. The diagnostic criteria for ICUAW are practical, based on history and clinical examination: (1) generalized weakness developing after the onset of critical illness; (2) weakness is diffuse (involving both proximal and distal muscles), symmetric, flaccid, and generally spares cranial nerves; (3) MRC sum score <48, or mean MRC score <4 in all testable muscle groups noted on more than two occasions separated by >24 h; (4) dependence on mechanical ventilation; and (5) causes of weakness not related to the underlying critical illness excluded. To make a definitive diagnosis of ICUAW, costly or invasive tests such as electromyography, single-nerve condition studies, muscle biopsy, and muscle ultrasound are required. However, obtaining complete data from

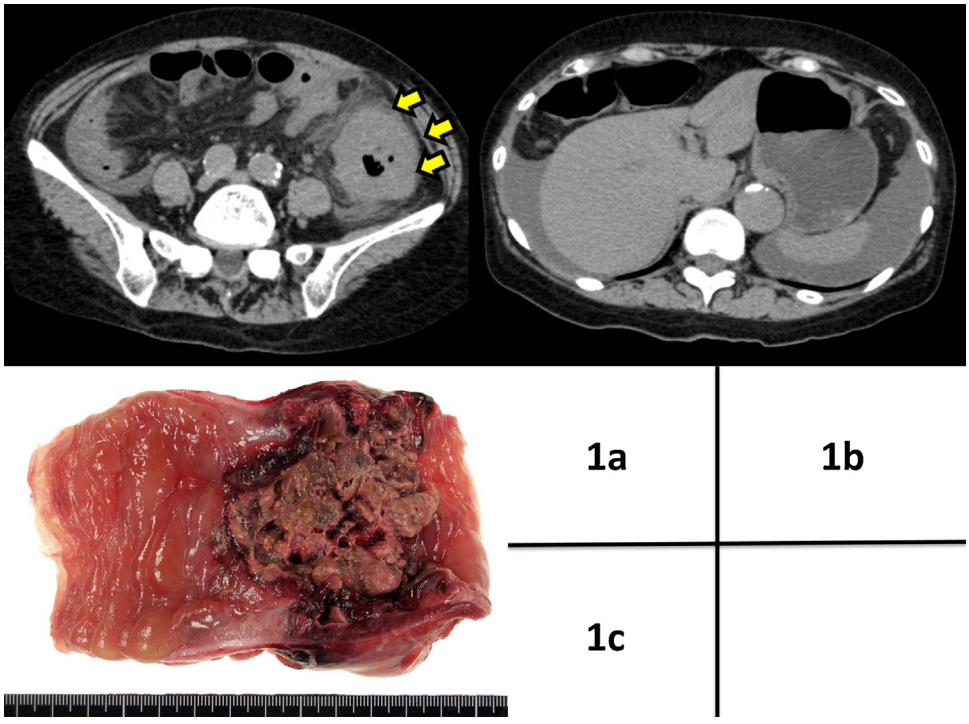


**Fig. 1.** Abdominal CT on admission and excised specimen findings. Abdominal CT shows thickness of the descending colon, swelling of surrounding lymph nodes, and ascites (a, b). A large tumor with necrosis is located in the descending colon. Lymph nodes surrounding the tumor show bulky swelling (c).

**Fig. 2.** Head CT. Head CT shows no abnormalities causing muscle weakness.

critically ill patients at the bedside remains challenging because of tissue edema and electrical interference [8]. The current patient presented with systemic weakness that spared the cranial nerves after emergency surgery for acute abdomen. She had an MRC sum score of 0 and could not be weaned off mechanical ventilation. Since various examinations could not identify an organic cause for paralysis, a presumptive diagnosis of ICUAW was made.

It has been reported that about 26–65% patients who require mechanical ventilation have weakness on awakening [4,5], and the longer the patients are ventilated, the higher the incidence of muscle weakness [9].

The clinical condition and pathogenesis of ICUAW have not been fully determined. However, it has been reported that the humoral immune reaction due to a severe condition such as septic shock, multiple organ failure, and acute respiratory distress syndrome plays an important role in the development of ICUAW [4]. The production of various types of cytokines leads to degeneration of nerve conduction, microvascular hyperpermeability due to degeneration of microvessels, and production of neurotoxic agents. In addition, muscle breakdown is directly affected by metabolic disease, inflammatory changes, and loss of energy [10]. In ICUAW patients, not only skeletal muscle, but also the diaphragm can be affected [11]. Thus, such patients usually fail weaning off mechanical ventilation that cannot be explained by their respiratory and circulatory status.

ICUAW is often characterized by symmetrical weakness of the limbs that affects proximal muscles more than distal muscles [12]. The function of cranial nerves is usually unaffected [13]. Thus, patients with ICUAW typically grimace with painful stimuli but show no withdrawal of the limbs. The present patient showed a prolonged need for mechanical ventilation despite improvement of her general condition. In addition, she showed a discrepancy between the facial muscles and core muscles, as discussed above.

ICUAW is associated with delayed weaning from ventilation, longer ICU stay, and increased ICU/hospital mortality [14]. In a recent study, patients with weakness showed a decline over time from 36% at hospital discharge to 22% at 3 months, 7–15% at 6 months, 4–14% at 1 year, and 9% at 2 years [15]. In general, septic patients with multiple organ failure have a high mortality, up to 60% [16]. Among the survivors, patients whose general condition improves in the relatively early phase tend to avoid worsening of ADL on a long-term basis [4]. Thus, the main risk factor for ICUAW appears to be the severity of illness. Therefore, early and rigorous intensive care is crucial to decrease mortality and improve long-term outcomes [17]. Another study reported that sarcopenia, use of vasopressors, corticosteroids, neuromuscular blockage, and aminoglycoside therapy, immobilization, and hyperglycemia were independent risk factors for neuromuscular complications [8,18]. In the present case, the patient had extremely severe septic shock and required prolonged use of vasopressors, and her muscle weakness did not recover for a long time.

There are no specific therapeutic options for preventing or treating ICUAW. Risk factor avoidance or modification might reduce the severity and risk of ICUAW. One aspect of treatment for ICUAW is prevention of contractures and pressure ulcers by early rehabilitation and frequent position changes [19]. Malnutrition was originally considered a contributor to ICUAW, so early tube feeding should be considered [20].

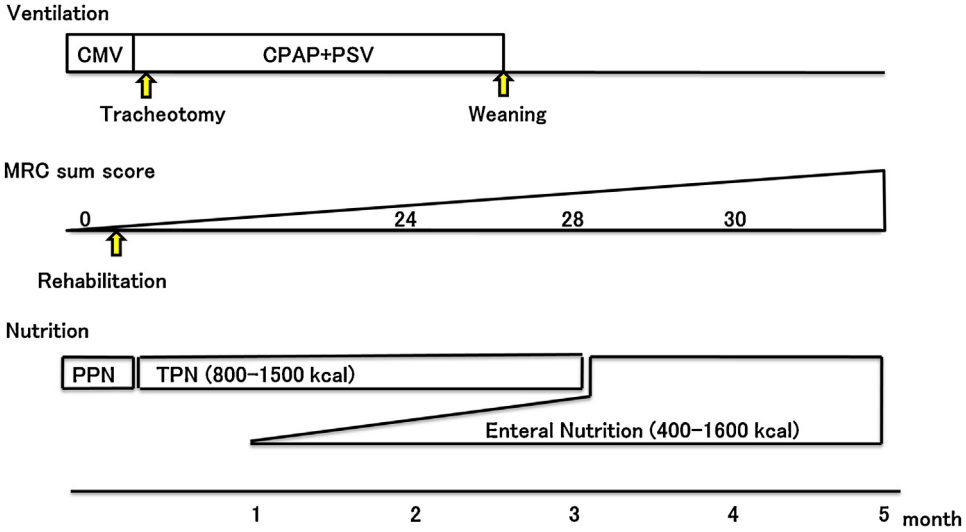


**Fig. 3.** Clinical course. MRC: Medical Research Council, CMV: continuous mandatory ventilation, CPAP + PSV: continuous positive airway pressure + pressure support ventilation, PPN: peripheral parenteral nutrition, TPN: total parenteral nutrition.

Jolley and colleague reported that critical illness can be categorized into four phases: pre-ICU, early ICU, late ICU, and post ICU [8]. They suggested that assessment and interventions targeting individualized stages could be an effective strategy.

The concept of ICUAW has been generally recognized among intensive care clinicians, and many reports have been published in the field of critical care. However, few studies have been reported in the field of general surgery [21]. Thus, it is important to collaborate with healthcare providers such as nurses, nutritional support teams, and physical therapists to prevent the development of ICUAW. ICUAW should be diagnosed earlier, and appropriate prevention and management could prevent a decrease in long-term ADL.

## 4. Conclusion

Surgeons commonly operate on patients with critical illnesses, and ICUAW is not rare condition in such patients. All physicians who care for critically ill patients should take active steps to diagnose ICUAW in order to avoid decreases in patients' ADL.

## Conflict of interest

None.

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This study was not supported by any grant.

## Ethical approval

Not applicable.

## Consent

Written and signed consent from the patient to publish a case report has been obtained.

## Author contributions

Tetsuro Tominaga, Takashi Nonaka, Hiroaki Takeshita, and Toshio Shiraishi developed the study concept. Yuichiro Honda and Hiroki Nagura performed rehabilitation. Masaki Kunizaki, Yorihisa Sumida, and Shigekazu Hidaka collaborated in medical care. Terumitsu Sawai and Takeshi Nagayasu were involved in manuscript revision.

## Guarantor

Terumitsu Sawai.

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